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A61B 3/00, G01B 9/02, H03L 7/00Somerville, MA 02145 (US). TEARNEY, Guillermo, J.
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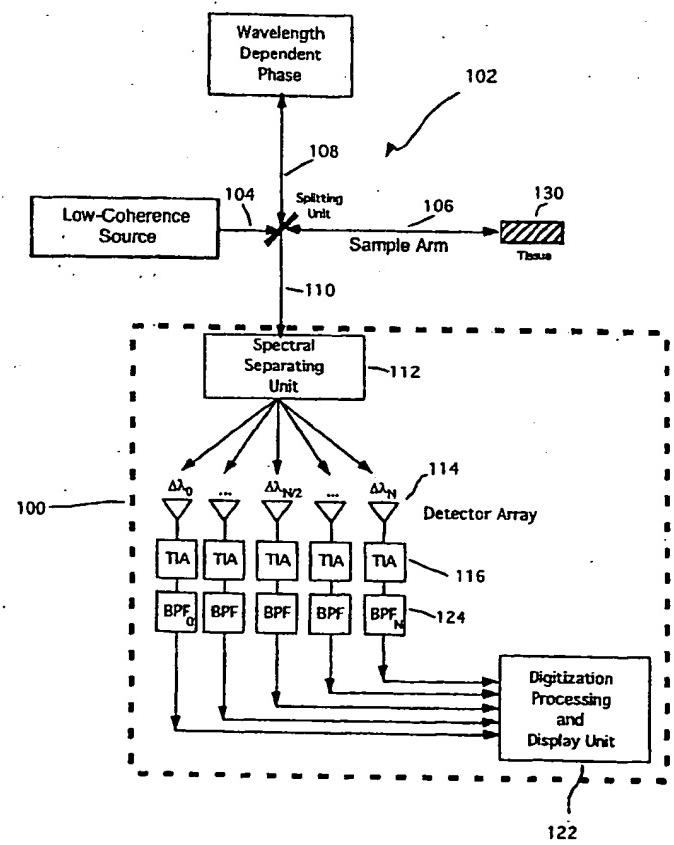
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60/351,904 24 January 2002 (24.01.2002) US
10/136,813 30 April 2002 (30.04.2002) US(71) Applicant (for all designated States except US): THE
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[Continued on next page]

(54) Title: APPARATUS AND METHOD FOR RANGINGS AND NOISE REDUCTION OF LOW COHERENCE INTERFER-
OMETRY LCI AND OPTICAL COHERENCE TOMOGRAPHY (OCT) SIGNALS BY PARALLEL DETECTION OF SPECTRAL
BANDS

(57) Abstract: Apparatus, method, logic arrangement and storage medium are provided for increasing the sensitivity in the detection of optical coherence tomography and low coherence interferometry ("LCI") signals by detecting a parallel set of spectral bands, each band being a unique combination of optical frequencies. The LCI broad bandwidth source can be split into N spectral bands. The N spectral bands can be individually detected and processed to provide an increase in the signal-to-noise ratio by a factor of N. Each spectral band may be detected by a separate photo detector and amplified. For each spectral band, the signal can be band pass filtered around the signal band by analog electronics and digitized, or, alternatively, the signal may be digitized and band pass filtered in software. As a consequence, the shot noise contribution to the signal is likely reduced by a factor equal to the number of spectral bands, while the signal amplitude can remain the same. The reduction of the shot noise increases the dynamic range and sensitivity of the system.

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ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI,
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01N A61B G01B H03L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category ^a	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 134 003 A (BOPPART STEPHEN A ET AL) 17 October 2000 (2000-10-17) column 16, line 36 -column 17, line 24; figure 16	1-58,71, 101,102
X	US 5 317 389 A (HOCHBERG ERIC B ET AL) 31 May 1994 (1994-05-31) column 5, line 45 -column 6, line 19; claims 1,2; figure 2	1-58,71, 101,102
A	US 6 141 577 A (DELFYETT JR PETER J ET AL) 31 October 2000 (2000-10-31) column 4, line 50 -column 5, line 37; figure 3	1-58,71, 101,102

 Further documents are listed in the continuation of box C. Patent family members are listed in annex.

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- "E" earlier document but published on or after the international filing date
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	TEARNEY G J ET AL: "IN VIVO ENDOSCOPIC OPTICAL BIOPSY WITH OPTICAL COHERENCE TOMOGRAPHY" SCIENCE, AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE,, US, vol. 276, no. 5321, 27 June 1997 (1997-06-27), pages 2037-2039, XP001041246 ISSN: 0036-8075 figure 1 ---	1-58, 71, 101, 102
A	WO 99 44089 A (GEN HOSPITAL CORP ; TEARNEY GUILLERMO J (US); BOUMA BRETT E (US); W) 2 September 1999 (1999-09-02) figure 1 ---	1-58, 71, 101, 102
X	US 4 925 302 A (CUTLER GREGORY M) 15 May 1990 (1990-05-15) column 5, line 14 -column 6, line 25; figures 3,4 ---	59-69, 85, 86, 88-90, 92, 93, 98
X	US 4 631 498 A (CUTLER GREGORY M) 23 December 1986 (1986-12-23) claims 1-6; figure 1 ---	59-69, 85, 86, 88-90, 92, 93, 98
A	GB 2 209 221 A (LITTON SYSTEMS INC) 4 May 1989 (1989-05-04) figure 6 ---	59-69, 85, 86, 88-90, 92, 93, 98
A	US 6 069 698 A (TAKIZAWA HIRONOBU ET AL) 30 May 2000 (2000-05-30) the whole document ---	59-69, 85, 86, 88-90, 92, 93, 98
A	US 5 491 552 A (KNUETTEL ALEXANDER) 13 February 1996 (1996-02-13) column 3, line 41 -column 7, line 62 ---	59-69, 85, 86, 88-90, 92, 93, 98
A	US 5 321 501 A (HUANG DAVID ET AL) 14 June 1994 (1994-06-14) column 6, line 22 -column 9, line 2; figure 1A ---	59-69, 85, 86, 88-90, 92, 93, 98

Patent document cited in search report		Publication date		Patent family member(s)		Publication date
US 6134003	A	17-10-2000	US	5748598 A		05-05-1998
			US	5459570 A		17-10-1995
			AU	1977597 A		16-09-1997
			EP	0883793 A1		16-12-1998
			JP	2000503237 T		21-03-2000
			JP	2002214127 A		31-07-2002
			US	6485413 B1		26-11-2002
			US	6111645 A		29-08-2000
			WO	9732182 A1		04-09-1997
			US	6160826 A		12-12-2000
			US	6564087 B1		13-05-2003
			US	6501551 B1		31-12-2002
			US	6282011 B1		28-08-2001
			US	5956355 A		21-09-1999
			US	2001036002 A1		01-11-2001
			WO	9701167 A1		09-01-1997
			US	5784352 A		21-07-1998
			WO	9723870 A1		03-07-1997
			WO	9533970 A1		14-12-1995
			DE	69227902 D1		28-01-1999
			DE	69227902 T2		17-06-1999
			EP	0581871 A1		09-02-1994
			JP	6511312 T		15-12-1994
			WO	9219930 A1		12-11-1992
			US	5465147 A		07-11-1995
			US	5321501 A		14-06-1994
US 5317389	A	31-05-1994	US	5071251 A		10-12-1991
			US	5054924 A		08-10-1991
US 6141577	A	31-10-2000	US	5921926 A		13-07-1999
			US	6072765 A		06-06-2000
WO 9944089	A	02-09-1999	AU	758078 B2		13-03-2003
			AU	2882399 A		15-09-1999
			EP	1057063 A1		06-12-2000
			JP	2002505434 T		19-02-2002
			WO	9944089 A1		02-09-1999
			US	6341036 B1		22-01-2002
			US	2002122246 A1		05-09-2002
US 4925302	A	15-05-1990		NONE		
US 4631498	A	23-12-1986	US	4746878 A		24-05-1988
GB 2209221	A	04-05-1989		NONE		
US 6069698	A	30-05-2000	JP	11072431 A		16-03-1999
			JP	11056752 A		02-03-1999
			JP	11148897 A		02-06-1999
US 5491552	A	13-02-1996	DE	4310209 A1		06-10-1994
			EP	0618439 A1		05-10-1994
US 5321501	A	14-06-1994	US	5465147 A		07-11-1995
			DE	69227902 D1		28-01-1999
			DE	69227902 T2		17-06-1999
			EP	0581871 A1		09-02-1994

Patent document cited in search report	Publication date		Patent family member(s)	Publication date
US 5321501	A	JP	6511312 T	15-12-1994
		US	5459570 A	17-10-1995
		US	6485413 B1	26-11-2002
		US	6111645 A	29-08-2000
		WO	9219930 A1	12-11-1992
		US	6160826 A	12-12-2000
		US	6564087 B1	13-05-2003
		US	6501551 B1	31-12-2002
		US	6282011 B1	28-08-2001
		US	6134003 A	17-10-2000
		US	5956355 A	21-09-1999
		US	2001036002 A1	01-11-2001

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Box I Observations where certain claims were found unsearchable (Continuation of item 1 of first sheet)

This International Search Report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.: because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.: because they relate to parts of the International Application that do not comply with the prescribed requirements to such an extent that no meaningful International Search can be carried out, specifically:

3. Claims Nos.: because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box II Observations where unity of invention is lacking (Continuation of item 2 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. As all required additional search fees were timely paid by the applicant, this International Search Report covers all searchable claims.

2. As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.

3. As only some of the required additional search fees were timely paid by the applicant, this International Search Report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this International Search Report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. Claims: 1-58, 71, 101, 102

apparatus for optical imaging employing an interferometer, a spectral separating unit, and a plurality of detectors.

2. Claims: 59-61, 62-66, 67-68, 69, 85-86, 88, 89, 90, 92, 93, and 98

apparatus for optical imaging employing an interferometer, a spectral separating unit, and a plurality of detectors.